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THE INFLUENCE OF TYPE OF SET AND PLANTING DISTANCE ON GRADES AND YIELDS OF POTATOES FOR SEED[1]

G. C. WARREN[2]

INTRODUCTION

It is the aim of seed potato growers to increase the production of saleable tubers in the sizes and grades most likely to meet with a ready market demand. However, the use of new varieties, better fungicides and insecticides, and improved growing practices, while increasing yields, has also tended to increase the production of large tubers of limited market value.

At the present time, the bulk of seed potatoes are sold in the A-size (3-12 oz.) and the B-size (1½-3 oz.) grades. Some tubers are marketed above and below these grades, but the largest quantity is sold in the A-size grade. A definite preference, however, is shown for the B-size grade, often at premium prices. Since tubers in the 1½-3 oz. range comprise approximately ten per cent of the average crop, an overall reduction in size, without an appreciable drop in yield, could increase grower profits considerably.

Many farmers are of the opinion that yields of seed potatoes can be increased by the close planting of whole tubers. Most of the experimental data bearing on this subject, however, deals with table potatoes. Montague and Ivins (6), working with King Edward seed of two grades over a range of planting distances from 12 to 32 inches, found that, in the case of both grades, total yields decreased and yields of potatoes over 2.25 inches in diameter increased slightly with increased interplant distances up to 32 inches.

In an experiment at Benares Hindu University, Kapoor (5) found that significant increases in the average size of tubers resulted from using smaller seed pieces and also from wider spacing.

Jahnl (4), in a three-year trial with three early potato varieties, showed that seed cutting never increased, but often depressed, yields. In all three varieties uncut seed yielded the highest number of tubers per plant, but in two varieties the average weight of the tubers was lower. The effect of cut seed on size distribution was found to vary with year and variety.

In West Virginia (11) it was found that whole potato sets produced better stands than did cut sets of the same size and, in the Irish Cobbler variety, gave generally higher yields, though in the late variety, Sebago, cut sets produced the highest yield.

Reestman (8) carried out 56 field experiments in the Netherlands in 1940-1942 to determine the practicability of using small seed potatoes of the 25-28 mm. grade. At rates of 40 and 50 thousand plants per hectare, the small-grade seed potatoes (25-28 mms.) yielded an average of 2.5 metric tons per hectare (1 ton per acre) less than the 28-35 mm. grade.

[1]Accepted for publication March 27, 1958.
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However, the 25-28 mm. grade seed, planted at 60 thousand plants per hectare, yielded 400 kgs. per hectare more than the 28-35 mms. grade planted at 40 thousand plants per hectare (the normal rate of planting). The conclusion reached is that the practice of using 25-28 mms. seed, closely spaced, is a safe one and to be recommended, whenever financially advantageous.

Peterson and Frederikson (7) in an experiment on the cutting of seed potatoes, found the yields from halved 100-gram sets of 6 varieties to be 4.17 per cent lower than those from whole 50 gram tubers. A second trial with one variety in the following year showed that, if cutting is necessary, it should be carried out 3 to 6 days prior to planting.

Werner (10) grew three varieties of potatoes on dry land in Western Nebraska using three planting rates and combinations of two seed piece sizes at two planting distances. The trials over several years indicated that the intermediate planting rate, approximately 12 bushels per acre, gave the highest yields. With this rate, close planting of small seed pieces was preferable to planting seed pieces of double the weight at twice the distance.

Houghland and Parker (3), in an experiment using 30 and 36-inch row spacings, 10, 15, and 18 inch seed spacings, and 1,500, 2,000, and 2,500 pound fertilizer rates, found that the greatest financial returns were realized from seed spaced 15 or 18 inches, in rows 36 inches apart and from the 2,000 pound application of fertilizer. Yields of primes were generally increased when the seed was spaced closer, but these increases were not always significant, nor were they always economical from the standpoint of the cost of additional seed required. Of the three factors studied, seed spacing was found to have the greatest influence on yield, acting independently of row spacing with the exception of one year.

Chucka and Steinmetz (1) compared the yield from different sizes of tubers, both whole and cut, of the Green Mountain, Katahdin and Sebago varieties and concluded that 1: yield increased as size of piece increased for both whole and cut seed; 2: whole seed gave somewhat higher yield than cut seed for pieces of similar weight; 3: the number of stalks per plant and number of tubers per hill increased as size of piece increased; and 4: there were more oversized tubers on plants from the smallest seed pieces.

Hardenburg (2), in a study of the relation of seed spacing to yield on 157 New York farms, found that growers who plant closest not only average a higher yield and require more seed to the acre, but also get a higher yield for each bushel of seed planted.

In an experiment to study the relation of size of seed piece to yields of Green Mountain potatoes spaced 9 inches apart, Sprague and Evaul (9) found that 1: as size of piece increased from ½ ounce to 1½ ounces, that the yield increases as amount of seed per acre increases. 2: when amount of seed per acre is constant, pieces as small as 1 ounce not only give as much yield as larger pieces, but also result in a higher yield per bushel of seed planted.

Materials and Methods

Four varieties, Green Mountain, Irish Cobbler, Katahdin and Sebago were used in this experiment. The plots were laid out in a factorial

design with the varieties making up twelve main plots in each of two replications. Each of the main plots contained twelve randomized subplots consisting of each combination of distance and type of set, or a total of 96 plots. Since the straight yield comparison between the four varieties was not of particular interest, some of the accuracy of that comparison was sacrificed in order to gain greater accuracy for the distance and type of set comparison.

The plot size was a single row 30 feet in length with each of the two replications occupying a piece of land as nearly square as possible.

A 5-10-10 fertilizer, at the rate of 1,800 pounds per acre, was applied broadcast across the rows.

All sets used were 1½ ounces of the following types: 1—whole tubers; 2—halved tubers; 3—cut tubers, random size.

The spacing distances used were: 6 inches, 8 inches, 10 inches and 12 inches, respectively.

The yields recorded are for perfect stands calculated by standard procedure.

All tubers were harvested at the end of the season and graded according to Canada Department of Agriculture seed standards.

Results and Discussion

Since this experiment was designed to study the effect of spacing and type of seed set on the production of standard grade (A and B size) and large tubers (over 12 ounces) no special emphasis has been placed on varietal reactions, but tables on this phase of the experiment have been prepared and are available to those interested.

It is evident from the data given in table 1 that a significant reduction in yield of large tubers was obtained from both whole and halved tuber sets, when compared with sets cut from random stock, though yield differences, in some instances, may be quite narrow. On the other hand, relatively large and significant increases in B-size tubers were obtained for whole sets and, to a lesser degree, for halved sets. The production of A-sized tubers also increased in a similar but not significant manner. These influences are reflected in increased total yields.

The yield trends shown for type of set (Table 1) are similar in proportion as spacing distances are reduced (Table 2). Therefore, it is apparent, that spacing has the same general effect on tuber size and production as has type of set and that as spacings decrease, significantly higher yields are obtained for standard grades as well as for total production. The trend to smaller sized tubers also follows a similar but more pronounced pattern.

The results of the combined effect of spacing distance and type of set, as summarized in table 3, serve to emphasize the importance of each on the yield of B-size tubers. Furthermore, although the interactions show no significance for large tuber production or total yield, as spacings decrease and portion or set to whole tuber increases, there is a decided upward trend in standard grade yields and total production. This is followed by a reduction in number of tubers above the A-size limit. Since the object of the experiment was to reduce tuber size, and, at the same time, increase total production, this object would appear to have been achieved.

TABLE 1.—*The effect of type of set on grades and yields of seed tubers.*

Type of Set	Large, Over 12 oz.	Standard Grades		Small, Under 1½ oz.	Total Standard Grades	Total Yield
		"A" (3-12 oz.)	"B" (1½-3 oz.)			
		Bus./Acre	Bus./Acre	Bus./Acre	Bus./Acre	Bus./Acre
1	12.90	315.98	62.47	25.84	378.45	417.19
2	17.75	308.86	53.66	23.36	362.52	403.63
3	27.72	305.66	41.37	17.73	347.03	392.49
L.S.D 5 per cent	4.51	N.S.	3.09		12.35	12.90

1 : 1½ oz. whole tubers.
2 : 1½ oz. halved 3 oz. tubers.
3 : 1½ oz. cut sets from random stock.

TABLE 2.—*The effect of spacing on grades and yields of seed tubers.*

Set Spacing	Large, Over 12 oz.	Standard Grades		Small, Under 1½ oz.	Total Standard Grades	Total Yield
		"A" (3-12 oz.)	"B" (1½-3 oz.)			
	Bus./Acre	Bus./Acre	Bus./Acre	Bus./Acre	Bus./Acre	Bus./Acre
6 in.	12.62	330.15	71.09	30.12	401.24	443.98
8 in.	17.75	314.01	55.31	23.61	369.32	410.68
10 in.	21.94	302.03	45.16	18.90	347.19	388.03
12 in.	25.53	294.47	38.43	16.63	332.90	375.06
L.S.D 5 per cent	5.20	14.79	3.57		14.26	14.89

SUMMARY

An experiment to study tuber size and yield of potatoes in relation to spacing distance and type of set, using four standard varieties, was conducted over a five-year period at the Experimental Farm, Charlottetown, Prince Edward Island. It was found that 6-inch spacings of whole or halved tuber sets of 1½ ounce weight produced significantly higher yields of standard seed tubers than did 12-inch spacings of 1½ ounce sets cut from random-sized tubers; and that an increase in B-size (1½-3 oz.) tubers occurred as the proportion of set size to whole tuber size increased and distance between sets narrowed. It was evident, also, that a similar trend was followed in the reduction of tuber number above the A-size (3-12 oz.) limit. Variety reactions, although a minor part of this experiment, were quite similar.

TABLE 3.—*Combined effect of spacing and type of set on grades and yields of seed tubers.*

Planting Treatment All Sets 1½ Ounces		Large, Over 12 oz.	Standard Grades		Small, Under 1½ oz.	Total Standard Grades	Total Yield
Set Spacing	Type of Set		"A" (3-12 oz.)	"B" (1½-3 oz.)			
		Bus./ Acre	Bus./ Acre	Bus./ Acre	Bus./ Acre	Bus./ Acre	Bus./ Acre
6 inch	Whole Tubers	6.33	323.11	87.92	35.03	411.03	452.39
6 "	Halved 3 oz. tubers	10.52	335.24	70.43	31.33	405.67	447.52
6 "	Random cut	21.00	332.11	54.93	24.00	387.04	432.04
8 "	Whole Tubers	13.24	320.02	59.70	26.48	379.72	419.44
8 "	Halved 3 oz. tubers	15.31	305.88	62.17	25.81	368.05	409.17
8 "	Random cut	24.71	316.13	44.05	18.53	360.18	403.42
10 "	Whole Tubers	13.76	313.96	53.84	22.38	367.80	403.94
10 "	Halved 3 oz. tubers	18.81	298.50	45.73	19.33	344.23	382.37
10 "	Random cut	33.25	293.64	35.90	14.99	329.54	377.78
12 "	Whole Tubers	18.28	306.84	48.41	19.44	355.25	392.97
12 "	Halved 3 oz. tubers	26.35	295.81	36.29	17.02	332.10	375.47
12 "	Random cut	31.97	280.76	30.58	13.43	311.34	356.74
L.S.D. 5 per cent		N.S.	N.S.	6.17		N.S.	N.S.

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The author wishes to thank Dr. H. B. Cannon, Division of Horticulture, Ottawa, for his advice on the design of this experiment; also, Messrs. K. E. LeLacheur and G. W. Boswall, Experimental Farm, Charlottetown, for assistance with the statistical analyses.

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SURVEY OF SPECIFIC GRAVITY OF RUSSET BURBANK POTATOES GROWN IN CENTRAL OREGON AND THE KLAMATH BASIN, 1957 CROP[1]

ANDREA MACKEY,[2] SUE JOINER,[3] IDA CECIL[3] AND JOY STOCKMAN[3]

The purpose of this paper is to report the findings of a survey made to determine the specific gravity of late-crop potatoes from two major producing areas, Central Oregon and the Klamath Basin. The survey was undertaken to provide information, not only as to the average specific gravity, but as to the range and uniformity of the crop as a whole.

Detailed and extensive sampling of a crop in a given year is a valuable preliminary for related studies in which specific gravity is the factor used for establishing correlations. Without this background information, it would be impossible to estimate whether small samples selected for intensive study are representative of the crop or not. To have significance for the crop as a whole, a small sample should, as nearly as possible, represent the majority of the potatoes from the area under study.

The survey was therefore planned to provide a sampling of the whole potato crop. The procedure followed appears to be an innovation in studies of potato specific gravity. Although much work has been done on specific gravity of potatoes, no report was found in the literature describing the sampling of an entire area's commercially-produced crop.

PROCEDURE

To provide a representative sampling of the 1957 potato crop from the two major areas under consideration, farms were selected from a list totaling approximately 3000 growers. The sample farms, 108 in all, were located in Crook, Deschutes, Jefferson, Klamath, Modoc and Siskiyou Counties. Approximately 1/5 (18.9 per cent) of the total acreage harvested in these counties in 1957 was in the farms from which samples were drawn. The area of these farms was 5492 acres, and the total area harvested was 29,000 acres. Early crop potatoes, grown largely at the Oregon-Idaho border were not included in this study.

With the cooperation of the growers, Federal-State of Oregon Shipping Point Inspectors arranged to collect potatoes from each of the farms. This was done immediately after harvest, directly from farm cellar storage. From three to six samples of 8 to 12 pounds were drawn from each of the selected cellars. When possible, the samples were taken at different locations in the cellar, better to represent the farm's whole crop. The collection was complete within two weeks after harvest.

Each 8 to 12 pound sample was labeled with the name of the grower, the potato acreage of the farm and the approximate tonnage of potatoes produced. The samples were shipped or brought immediately to the research laboratory at Oregon State College, where specific gravity was determined.

[1]Accepted for publication March 24, 1958.

[2,3]Professor and Instructors, respectively, Home Economics Research, Agricultural Experiment Station, Oregon State College, Corvallis, Oregon.

An apparatus which is standard equipment in the potato chip industry was used for determining specific gravity of each of these samples, (Figure 1). The hydrometer was calibrated in the Oregon State College Laboratory for use of 7½ pounds of potatoes, although 8 pounds are usually used with this apparatus. Many of the potatoes grown in this region tend to have such high specific gravity, it was necessary to use a smaller load, or the hydrometer would have been pulled down out of sight in the water. The specific gravity of each 7½ pound sample, 431 samples in all, was read directly on the hydrometer. Determined in this way, each specific gravity reading represented an average of all the tubers placed in the basket at one time.

The specific gravity of individual tubers, randomly selected, was determined for 7 to 8 pounds of potatoes from each farm, using the method of brine flotation. The brine solutions had specific gravities of 1.065, 1.070, etc. to 1.125. Tubers were moved from one solution to another until they floated on the longitudinal axis. When they floated in this way, the potatoes were classed as being of the same specific gravity as the solution. Specific gravity was determined individually on 1,521 tubers.

Results and Discussion

The data obtained on individual tubers were used for estimating the distribution by specific gravity class of the entire potato crop. The production of a large farm would have more effect on the overall crop than the tonnage from a smaller acreage. Hence, tubers from each farm which fell in a given specific gravity class were weighted by the tonnage reported for that farm.

The range of all tubers was from 1.070 to 1.120. Approximately seven-eighths of the crop fell in the specific gravity classes, 1.085 to 1.105 (86 per cent). Nearly two-thirds had a specific gravity of 1.090 to 1.100 (62 per cent).

The specific gravity of Russet Burbank potatoes is high in comparison with other major potato varieties. In 1947, 1948 and 1949, Heinze, Kirkpatrick and Dochterman (1) studied potatoes from different states. In 1947 they collected nine varieties from eleven states, and found that the specific gravities ranged from 1.062 for Katahdin from Pennsylvania to 1.105 for Russet Burbank from Washington. In 1948 and 1949 they studied six major varieties collected from states that produced approximately two-thirds of the total late crop. Specific gravity of these potatoes ranged from 1.064 for Chippewa from Indiana to 1.100 for Russet Burbank from Washington. When specific gravities for the two seasons and various locations were averaged, the figures were: Chippewa, 1.073; Green Mountain, 1.088; Irish Cobbler, 1.087; Katahdin, 1.085; Russet Burbank, 1.093; and Triumph, 1.088.

In comparison with the above figures, the specific gravity of Russet Burbank potatoes grown in Central Oregon and the Klamath Basin in 1957, averaged 1.092.

Reference

1. Heinze, Peter H., Kirkpatrick, Mary E. and Dochterman, Elsie F. 1955. "Cooking quality and compositional factors of potatoes of different varieties from several commercial locations." Tech. Bull. No. 1106, U.S.D.A., Washington, D.C., March.

FIGURE 1.—Method used for determining specific gravity of 7½ pounds of potatoes.

ACKNOWLEDGMENTS

The willingness of all growers to assist in this survey by contributing potatoes from their farms made this study possible. The authors wish to extend their grateful appreciation to these men and women. The authors wish to express their thanks to Russ Stanard and Ross Aubrey who arranged to collect the samples from each farm and to deliver them to the research laboratory; and to Ben Davidson, Administrator of the Oregon Potato Commission, and Cliff Jenkins, Executive Secretary of the Tulelake Growers Association, whose cooperation made it possible to select representative farms for sampling.

EFFECTS OF CERTAIN GROWTH SUBSTANCES ON NUMBER OF POTATO TUBERS[1]

H. W. GAUSMAN, E. G. CORBETT AND R. A. STRUCHTEMEYER[2]

Prodigious research has been conducted concerning applied chemicals (growth substances as opposed to native auxins) which modify growth of plants. Unfortunately, effects of growth substances on plants have been the object of much skepticism. This is reflected in the lack of fundamental information pertaining to indigenous and exogenous relationships of growth substances to many plants of current economic importance. One such example is the effect of growth substances on potato rhizomes as affecting subsequent tuberization and tuber development. This paper reports results of exploratory investigations which were developed from the premise that tuber-producing patterns of potato rhizomes can be altered by applications of growth substances.

LITERATURE REVIEW AND SUPPOSITIONS

No attempt has been made to include the voluminous literature citations relevant to growth substances. References given below are some of those which were conducive to the included suppositions from which the experiments reported herein evolved.

According to Hayward (6), polar growth of the rhizome axis ceases at the onset of tuberization which is followed by lateral proliferation of storage tissues.[3] Since the potato tuber is an enlargement of some portion of the rhizome, it seemed feasible that the auxin mechanism postulated for apical dominance of tubers might also apply to polar tuberization of rhizomes. In this respect, Michener (8) suggested in 1942 that auxin inhibits bud growth in dormant tubers and removal of auxin by ethylene chlorohydrin permits growth to proceed. Black (2) also contends that low concentrations of auxin enhance cell division and elongation whereas high auxin concentrations inhibit growth. In essence, a critical auxin level is proposed. Accepting the critical auxin concept as a premise, a chemical which antagonizes growth-promoting effects of auxin should be useful in evaluating whether polar tuberization is associated with auxin gradients in the rhizomes. Concurrent with this view, Bonner and Bandurski (3) have indicated that 2,4-dichloranisole and 2,3,5-triiodobenzoic acid antagonize auxin, although they report that 2,3,5-triiodobenzoic acid does have some growth promoting properties.

Another facet seemed deserving of consideration. Snyder (12) and Thomson (13) concluded that treating meristems with growth substances may cause enlargement or displacement of primordia resulting from mobilization of anabolic products such as carbohydrates and proteins toward location of treatment. Further support is given to this theory by the fact that applications of certain growth substances will alter the single-

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[2]Associate Agronomist, Graduate Assistant, and Head, Department of Agronomy, respectively, Maine Agricultural Experiment Station, Orono, Maine. The authors wish to acknowledge the help of Miss Arlene Burns, Laboratory Assistant.

[3]The term rhizome is being used in accordance with the definition by Robbins (10).

ear-producing pattern of certain single-cross corn varieties (4). The intrinsic cause of this effect remains unsolved.

Experimental Procedures

During 1956 a pilot study was conducted in sand culture in four sheet metal tanks lined with an inert material. Each tank was 32-inches wide, 8-feet long, and 8-inches deep. Sand within the tank consisted of 6-inches of pure quartz gravel, 1 mm. to 2 mm. in diameter. Sub-irrigation was conducted automatically with centrifugal pumps from reservoirs beneath the tanks. The nutrient solution as given by Houghland (7) was utilized. One-half tubers of the Kennebec variety of potato were planted and pruned to one stalk on emergence. Treatments were made on single plants without replication. These treatments consisted of aqueous solutions of 2,4-dichloranisole (DCA), 2,3,5-triiodobenzoicacid (TIBA), Indole-3-acetic acid (IAA), 2-naphthaleneacetic acid (NAA), and Dalapon each at concentrations of 10, 100, 1,000, and 2,000 ppm. TIBA and NAA were brought into solution with KOH unadjusted for pH. Two cc. of the growth substances were applied to punctured rhizomes with a hypodermic needle and syringe before gross evidence of tuberization and during tuber formation, at the approximate time all plants were in flower or bud stages.

In 1957 the substrate consisted of virgin Caribou loam soil in a series of 2-gallon pots. Twenty grams of an 8-16-16 fertilizer with 2 per cent MgO was applied to each plot and mixed with the soil. One-half tubers of the Katahdin variety of potato were planted. Each plant was pruned to contain one stem. The design in 1957 was a split-plot in triplicate with growth substances as main plots and irrigant application and foliar application as subplots. All treatments used were those which gave the best responses in 1956. These were 100 ppm TIBA, 100 ppm NAA, 2,000 ppm DCA, 1,000 ppm IAA, and 1,000 ppm Dalapon. Treatments were applied in 1957 during tuberization only. Twenty cc. of each material were applied to the foliage with an atomizer or 150 cc. were applied as an irrigant.

During both years, controls received equivalent quantities of distilled water as an injection, foliar application, or irrigant.

Statistical analyses were conducted according to methods given by Snedecor (11).

Results

Table 1 depicts results obtained during 1956. The data comprise an average of four concentrations, namely 10, 100, 1,000, and 2,000 ppm, given in variation (+ or −) about the mean of 12 untreated plants. With the exception of DCA applied before tuber formation, all growth substances tended to increase the dry weight of roots and tops, the most notable increase being provided by NAA. Most significant, however, was the indicated effect of TIBA, DCA, and Dalapon on increasing number of tubers or number of rhizomes when applications were made during tuberization. Dalapon and TIBA tended to increase the number of tubers per plant; whereas DCA tended to increase the number of rhizomes per plant. Slight increases in number of rhizomes per plant

TABLE 1.—*Average of four concentrations of growth substances showing effects of application before and during tuberization on characteristics of potato plants, 1956. (Data given as variation (+) or decrease (—) about mean of 12 untreated plants).*

Chemical Treatment	No. Tubers per Plant	No. Rhizomes per Plant	Longest Rhizome	Dry Weight		
				Tubers	Root	Tops
			Inches	Grams	Grams	Grams
Growth Substances Applied before Tuber Formation						
Check	12.3	2.9	10.8	15.5	9.5	15.5
TIBA	—3.74	+1.21	—6.84	—2.81	+3.18	+6.50
NAA	—5.33	—0.26	—4.23	—9.39	+11.01	+4.88
DCA	—4.96	+0.62	—7.80	—5.08	—3.27	—2.73
IAA	—4.42	+1.50	—3.08	—10.51	+5.36	+0.20
Dalapon	—3.39	—0.79	—4.90	—11.59	+5.06	+4.88
Growth Substances Applied During Tuber Formation						
TIBA	+4.66	—0.40	+2.92	+6.54	+0.32	+2.47
NAA	—2.45	—0.58	—2.31	—4.14	+4.09	+6.35
DCA	+0.32	+2.32	—4.25	+6.54	+1.94	+2.47
IAA	+1.11	—0.29	—1.03	—1.47	+1.51	+5.64
Dalapon	+5.06	—0.29	—0.14	+1.20	+0.65	—3.88

TABLE 2.—*Effect of various growth substances on rhizomes and tubers of the potato plant, 1957.*

Chemical Treatment	No. Tubers per Plant	No. Rhizomes per Plant	Dry Weight of Tubers (Grams)	Specific Gravity of Tubers
Check	7.66	11.00	251.30	1.0790
100 ppm TIBA	6.33	12.64	255.24	1.0821
100 ppm NAA	10.99	14.00	199.44[2]	1.0878[3]
2000 ppm DCA	15.83[1]	11.83	262.01	1.0819
1000 ppm IAA	7.99	9.83	242.20	1.0848
100 ppm Dalapon	8.16	8.50	264.68	1.0812

[1]Highly significant 1 per cent probability level.
[2]Reduction significant at 10 per cent probability level.
[3]Increase significant at 10 per cent probability level.

were also indicated with applications of TIBA, DCA, and IAA made before tuberization.

Highly significant results were obtained with DCA in 1957 as indicated in table 2. The number of tubers per plant was increased approximately 52 per cent with 1.34 tubers per rhizome as compared with the check. Dry weight of tubers, however, was not significantly affected. The effects of NAA upon decreasing the dry weight of tubers and upon increasing specific gravity were significant at the 10 per cent probability level.

A variety of effects was encountered. A common occurrence was the formation of many tubers on a rhizome giving a grape cluster appear-

TABLE 3.—*Comparison of foliar and irrigant applications of growth substances as affecting number of tubers per plant, 1957.*

Treatment	Foliar	Irrigant	Foliar *vs.* Irrigant	Variation with Check
Check	6.00	9.33	—3.33	
TIBA	6.00	6.66	—0.66	—2.67
NAA	12.66	9.33	+3.33	—6.66[1]
DCA	9.66	22.00	—12.34	+9.01[2]
IAA	8.66	7.33	+1.33	—4.66
Dalapon	9.00	7.33	+1.67	—5.00

[1]Significant at 5 per cent level.
[2]Significant at 1 per cent level.

ance. Many of the smaller tubers were often misshapen. In some instances, plants had many small tubers attached close to the stem. DCA was the most consistent in causing many tubers to arise from one rhizome, but this effect was not evident on every rhizome for a particular plant.

Table 3 indicates that the irrigant application was superior to the foliar application for DCA, with significance at the one per cent probability level. In contrast, the foliar application was superior for NAA, although significance was attained only at the 5 per cent probability level.

DISCUSSION

The Kennebec and Katahdin varieties of potatoes normally produce one tuber on the terminal end of a rhizome. DCA significantly affected the number of tubers per plant. Two methods of increasing the number of tubers indicated by the results were (1) by increasing the number of rhizomes per plant, and (2) by increasing the number of tubers per rhizome.

Since DCA is an auxin antagonist and apparently differs from TIBA (classed as an antiauxin) which has some growth promoting properties (3), the feasible explanation for the increased number of tubers would seem to be associated with an auxin gradient within a rhizome or between rhizomes. Artschwager (1) reports that tuber formation begins on the first internode back of the rhizome's apical bud. In this respect, Gordon (5) indicates that buds in terminal position suppress development of lateral or axillary buds basipetal to them, and if auxin production of the terminal bud is limited, development of lateral buds occur. Plaisted (9) further indicates that an auxin mechanism may exist between rhizomes, since rhizome formation usually begins at the lower nodes near the seedpiece with the first tubers forming on the lower rhizomes which tend to become dominant and therefore largest. It is apparent, therefore, that auxin functions as a correlation agent in potato rhizomes or at least as the primary agent in the usual suppression of tubers basipetal to the apical bud. This suggests the need of research on segments of rhizomes treated with DCA to determine if auxin gradients exist.

Practical implications are dependent on the response to field tests. Even though the number of tubers per plant may be increased, accepted

cultural practices may limit an increased number of marketable tubers of acceptable quality.

Summary

In sand and pot culture, 2,4-dichloranisole, an auxin antagonist, increased the number of potato tubers per plant by apparently affecting apical dominance. Auxin as a growth correlation agent is discussed in relation to apical dominance in and between rhizomes.

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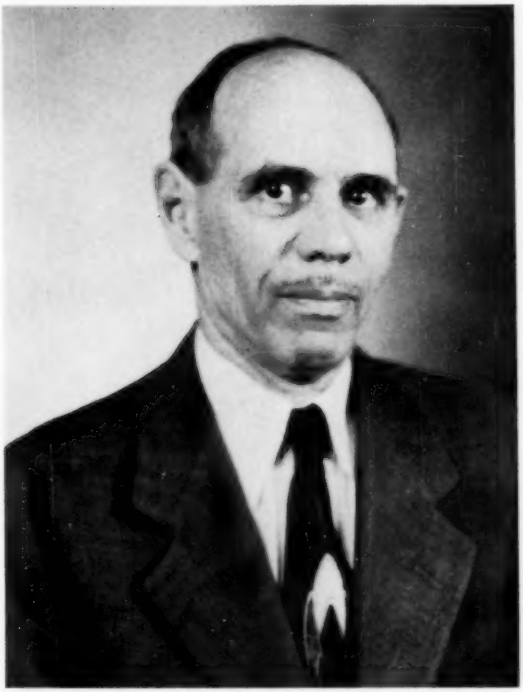
NEWS AND REVIEWS



DR. JOHN BUSHNELL HONORED

When our president, Mr. N. M. Parks, asked me to prepare a biographical sketch on Dr. John Bushnell, I was pleased. Many of the members of this association have known him far longer than I. He has been very kind to me on many occasions. Now I hope I can repay him in this small way for his many kindnesses.

Our member to be honored was born near Minneapolis on March 12, 1893. He received his bachelor of science degree from the University of Missouri. In 1918 he received the master of science degree from the University of Minnesota, while on the staff of the Minnesota Agricultural Experiment Station. Some of his early work pertained to plant breeding.

However, his interest in plant physiology increased, and he started working on temperature relationships in potato production. This was continued at the University of Chicago where he earned his doctor of philosophy degree.

Dr. Bushnell moved to Ohio in 1923 after joining the staff at the Ohio Agricultural Experiment Station, where he conducted research work on potatoes and other vegetables until his retirement on January 1, 1958.

He is now serving as a consultant to the Growers Chemical Corporation, Milan, Ohio.

Like many other leaders of the potato industry, he has devoted most of his life to potatoes. He was president of the Potato Association of America in 1930 and is a life member of the Ohio Vegetable and Potato Growers Association.

Some of this early research relative to effecs of temperature on growth of the potato plant has been of interest to potato men in many countries. In Ohio his research on the oxygen requirement of potato roots has led to other work on moisture relationships, rotations, irrigation and selection of soils for potatoes. This basic research indicated potato roots needed much larger quantities of oxygen than many other crops.

For many years potato yields in various parts of Ohio were declining. This was especially true on the experimental farm at Wooster. Obviously this caused much concern. Some experts attributed this decline to diseases in the soil, deterioration of varieties and other causes. But it remained for Dr. Bushnell to prove that the decline was due to reduction in soil aeration or lack of sufficient pore space.

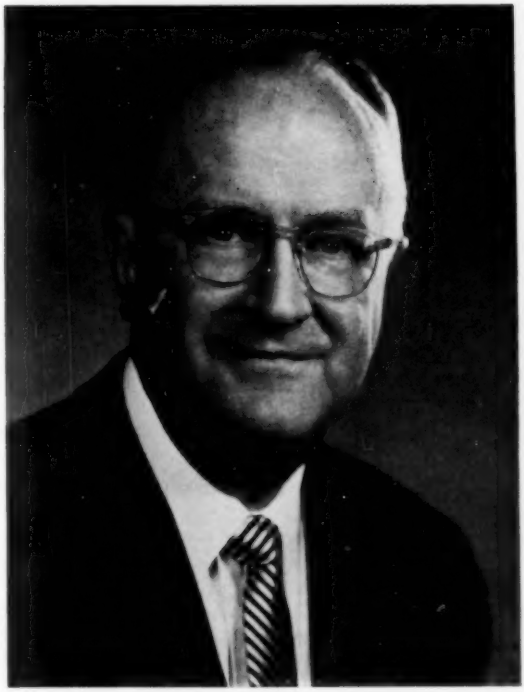
Dr. Bushnell is a tireless worker, spending many hours in laboratory and field. He has cooperated with extension workers in Ohio by sharing data with them, helping with preparation of bulletins, visual aids, etc. He has worked with other crops, but I am confident his first desire is to conduct research on potatoes. Nearly 50 articles on potatoes have been prepared by him for professional publications like the American Potato Journal, Soil Science, and others. In addition to these reports on potato research he has also prepared many other publications on other crops.

He has been characterized as an independent thinker, being willing to venture into new fields and has frequently developed new approaches. These characteristics are those of a true scientist. Many times he has expressed his views on subjects, knowing that perhaps other points may be more popular, but his strong convictions indicated that a certain point should be made. Many examples could be cited to illustrate the point.

In 1922 Dr. Bushnell married one of his college class mates—Dyllone Hempstead. She graduated from the University of Minnesota with a bachelor of science degree in agriculture. They have four sons. John, Jr. has a doctor's degree in anthropology from California and is with the Mellon Institute; Robert is a statistician in the field of guided missiles and is presently working toward a doctor's degree at Wisconsin; Clifford has graduated from Wooster College, and William is a research fellow in Botany at Wisconsin.

Those of us in Ohio who are associated with the potato industry appreciate the work that has been done by Dr Bushnell and are happy to have him receive this national honor from the Potato Association of America. I congratulate you, Dr. Bushnell, upon your election to this exclusive group in our association.

E. C. WITTMEYER, *Extension Horticulturist, Ohio State University, Columbus 10, Ohio*



FRANK W. HUSSEY HONORED

Being, relatively speaking, a youngster in potato work in Maine, I feel a bit inadequate to do the job of introducing our honored guest, Mr. Frank Hussey who has been honored by this Association by being selected as an Honorary Life Member. All over the country, his name has been synonymous with the Maine Potato Industry for many years. I am sure he knows more people in the potato world than any other individual in the room. He has been connected with all phases of the industry over the years and to list all of his various affiliations would be a speech in itself. Some highlights of his career with potatoes are as follows:

He was born on a farm in Maysville, Maine in 1902, and graduated from the University of Maine in 1925.

He operated farms producing 500 acres of seed potatoes for many years.

Frank helped to organize, and was associated with, Maine Potato Growers, Inc. of Presque Isle (a cooperative sales organization) for 23 years serving as treasurer for 3 years and 20 years as its president.

He served on the USDA Potato Research and Marketing Advisory Committee for 8 years, and was its Chairman for 2 years.

He was Chairman of the Task Group for White Potato Products to

the President's Appointed Bipartisan Commission on Increased Industrial Use of Agricultural Products.

He presently serves as exeeutive vice-president of the Maine Potato Council and Director of the National Potato Council, the Presque Isle Starch Company and the Aroostook Valley Railroad.

Activities worthy of note not directly connected with the potato industry include the following:

1. Trustee of University of Maine since 1941.
2. First President of Maine Farm Bureau.
3. Served as President of Maine Extension Service .
4. Served as President of National Council of Farmer Cooperatives.
5. Served as Chairman of the State Committee on the White House Conference on Education, and was a delegate to the White House Conference in Washington.
6. Presented with the Service To Youth Award by the Y.M.C.A. for 25 years of service.
7. Appointed Chairman of the Maine Citizens Committee to study structure of the State Government.
8. Member of Board of Governors of Agricultural Hall of Fame.

Frank has 3 sons and one daughter. One son is now attending Purdue University, one is a lawyer and one serves in the Armed Services. His daughter is a secretary in the Dean's office at Boston University. Significantly, none of them are in the potato business.

To inject a bit of humor, I would like to mention Frank's political activities but since this is Maine's political season, I will refrain from mentioning his party affiliation and only say that he has latent political ability.

The one thing that is closer to Frank than potatoes is the telephone. You can hardly get him to go fishing if it takes him out of reach of a phone. It has jokingly been said that when Frank reaches his final resting place, he won't lie still unless a phone is installed.

In all seriousness, I know of no person in Maine more worthy of this honor and it is with a great deal of pride that I present it to you Mr. Frank W. Husey.

PAUL J. EASTMAN, *Chief,*
Division Plant Industry, Augusta, Maine

E. J. WHEELER HONORED

Ernest Joseph Wheeler was born on a fruit farm in the Finger Lakes section of New York state at the turn of the century and attended high school at Hammondsport, New York. After graduation from high school he worked approximately four years in Detroit in factories and in carpentry work. He attended Michigan Agricultural College (now Michigan State University) graduating from the four-year course with a Bachelor of Science degree in 1926 and a Master of Science degree in 1928.

In 1929, E. J. Wheeler began his many years of service to Michigan State University and was placed in charge of the potato research work at the Lake City Experiment Station. At this time he entered the cooperative potato breeding work of the United States Department of Agriculture and has been active ever since in this cooperative effort.

In 1931, he went to study at the University of Minnesota with Dr. F. A. Krantz and he worked as agent for the United States Department of Agriculture. After 2 years he returned to Michigan State. His potato research work has been involved in potato culture studies, potato breeding, and potato storage problems. His interest in potato storage construction and operation developed during the time that A. D. Edgar was stationed at Michigan on potato storage problems.

E. J. Wheeler was assigned by the United States Army to serve as Horticultural Consultant to the Japanese government in 1948-1949. During this time he was on leave of absence from Michigan State University. While in Japan he studied means of increasing food production by improving the Japanese potato crop. He concentrated his efforts on developing high quality seed and in variety improvement. In 1953 he was selected to go to Okinawa for two years as Chief of the Michigan State University mission to the University of the Ryukyus. He returned to Michigan State in 1955.

At the time of this writing Professor Wheeler is preparing to leave for Simla, India, to serve as Potato Cultural Consultant for the International Cooperation Administration. He is now serving his second term as director of the Potato Association of America.

His early research on hollow heart of potatoes demonstrated that closer spacing would reduce the incidence of this disorder. In 1928, he worked on potato spraying and prepared a bulletin on the subject for potato growers of Michigan. He helped to promote the Katahdin potato in Michigan by publishing results of his trials. This variety is still widely used in the state. His research with rye as a winter cover crop in potato culture for erosion control and for scab control has become a common practice in the potato growing areas of Michigan.

The Pontiac potato, released in 1936, is an important red variety still widely grown in sections of the United States. This seedling was selected by Professor Wheeler from a packet of true seed supplied by the potato breeding program of the United States Department of Agriculture. In 1944, E. J. Wheeler had a part in the release of the Menominee potato which was one of the first scab resistant varieties released in this country. While on assignment to Japan, one of the potato seedlings which he took with him became very popular. This potato which is grown in a region of the islands where 2 potato crops are produced annually has been named the Wheeler potato. In recent years another potato variety, Onaway, has been released for the early potato producing area near Bay City, Michigan.

Because of Professor Wheeler's many years of outstanding service to the potato industry and because of his contributions enumerated above, it is most appropriate that he should receive Honorary Life Membership in the Potato Association of America.

W. J. HOOKER' *Department of Botany and Plant Pathology, Michigan State University, East Lansing, Michigan*

MINUTES OF ANNUAL BUSINESS MEETING OF THE POTATO ASSOCIATION OF AMERICA

Indiana University, Bloomington, Indiana
Monday, August 25, 1958

Meeting called to order by *President* N. M. Parks at 9:30 A.M. President Parks called for reports of the standing committees as follows:

Program Committee—R. V. Akeley. Thirty-two papers on all phases of potato investigations were submitted to the chairman for presentation at the Annual Meeting. A symposium on internal blackspot of potato was arranged and presented August 27. Five qualified speakers from Maine, New York, Idaho, and California discussed the problem in their States. Report accepted.

Membership Committee—P. J. Eastman, reported a membership of 2300. It was suggested that emphasis be placed on obtaining members in the potato utilization field next year. Report accepted.

Sub-Committee on Sustaining Membership and Advertising—E. J. Wheeler, reported that there were 13 sustaining members. Report accepted.

Local Arrangements Committee—H. Erickson, reported that AIBS had been very helpful with local arrangements.

Editorial Committee—J. C. Campbell, reported that twenty-eight manuscripts are on hand which will supply the Journal for 7 months. Report accepted.

Handbook Committee—C. Hutchinson, reported that the manuscript for the Handbook was ready for printer. Discussion ensued on quantity buying, circulation, number to print, deadlines to be observed, and advertising. Report accepted.

Honorary Life Membership Committee—R. W. Hougas reported that the new members elected were Frank Hussey (Maine), John Bushnell (Ohio), and E. J. Wheeler (Michigan). Report accepted.

Potato Certification Committee—H. M. Darling. The use of a disclaimer clause was discussed. Decided not to use it until more detailed information is available. Report accepted.

Late Blight Investigations Committee—M. Gallegly. Report accepted. This report is published elsewhere in this issue.

Virus Disease Investigations Committee—W. Hooker. Report accepted.

Potato Utilization Committee—R. H. Treadway. Report accepted. This report is published elsewhere in this issue.

Potato Nutrition (Fertilization) Committee—G. V. C. Houghland. Report accepted. This report will be published.

Potato Varietal Nomenclature Committee—R. V. Akeley. Some discussion followed the report concerning the acceptance of the varietal description presented by the committee as a model to be used in future publications of news releases. Report accepted. This report will be published after potato breeders have an opportunity to make changes.

Committee on Genetics and Cytology of Tuber Bearing Solanums—L. A. Dionne. Report accepted.

The International Relations Committee—R. H. Larson. A manuscript listing the names of 336 workers in 146 laboratories exclusive of United States and Canada was presented for publication in the Journal. Report accepted.

The report of the *Committee on Arrangements for Invitational Papers,* to be presented at the annual meeting of the Potato Association of America to be held at Fredericton, Canada, in 1959 was given by R. H. Larson and accepted.

The report of the *Committee on Local Arrangements,* for the 1959 meeting of the Potato Association of America was given by L. C. Young and accepted. Some discussion followed concerning the exact meeting dates.

A report on the coordination of committees was presented by W. Hooker and accepted. On July 1, letters were sent to all committee Chairmen requesting written committee reports. Replies were obtained from all of the chairmen of the standing committees and from 10 of the 15 special committees.

Report of the Liaison Officer, Ora Smith, for the European Association for Potato Research and the Potato Association of America was received and accepted.

Respectfully submitted,
R. V. AKELEY, *Secretary*

MINUTES OF EXECUTIVE COMMITTEE MEETING

Indiana University
Monday Evening, August 25, 1958

Meeting called to order by *President* N. M. Parks at 7:30 P.M..

Members present: R. V. Akeley, J. C. Campbell, P. J. Eastman, W. J. Hooker, R. W. Hougas, D. S. MacLachlan, N. M. Parks, E. J. Wheeler.

Members absent: O. C. Turnquist.

Visitors: L. C. Young and D. A. Young.

The minutes of the Executive Committee Meetings held at Plant Industry Station, Beltsville, Maryland, December, 1958 were accepted.

The revised constitution with its new amendments was discussed and will be brought before the members at the business meeting on August 27 for their approval.

A *motion* was made by E. J. Wheeler, that the Executive Committee accept the varietal description format suggested by the Potato Varietal Description and Nomenclature Committee. It was seconded by D. S. MacLachlan and unanimously carried. A *motion* was made by P. J. Eastman that this committee circulate the proposed Potato Varietal Description to potato breeders in North America for suggestions and changes to be incorporated before it is published in the Journal. Seconded by W. J. Hooker. Motion carried.

A *motion* was made by P. J. Eastman that the list of names and addresses of the potato workers in other countries presented by the International Relations Committee be accepted and published in the December issue of the Journal. Seconded by D. S. MacLachlan and carried unanimously.

A *motion* was made by D. S. MacLachlan, that a notice be published in the Journal stating that an up to date Potato Association Membership list can be obtained by any member by writing to our Editor-in-chief, J. C. Campbell. Seconded by P. J. Eastman and carried unanimously.

Discussion of various problems relating to the Potato Handbook followed. A *motion*, that we publish the 1960 edition of the Handbook and that the subject be Potato Utilization was made by P. J. Eastman. Seconded by W. J. Hooker. Motion carried. A *motion* was made by P. J. Eastman, that 10,000 copies of the 1959 issue of the Handbook on Potato Varieties be printed for distribution. Seconded by J. C. Campbell. Motion carried.

A *motion* that committee reports be printed in the Journal was made by D. S. MacLachlan and seconded by W. J. Hooker. Motion carried.

Dates for the 1959 meeting in Fredericton, Canada, were discussed. A *motion* was made by D. S. MacLachlan that L. C. Young arrange suitable dates for the Fredericton meeting. Seconded by R. W .Hougas. Motion carried.

Meeting adjourned.

Respectfully submitted,
R. V. AKELEY, *Secretary*

MINUTES OF BUSINESS MEETING

Indiana University
Wednesday, August 27, 1958

Meeting called to order by *President* N. M. Parks at 9:30 A.M.

A *motion* was made by W. Sparks, that the minutes of the 1957 annual business meeting as published in the Journal be approved. Seconded by P. J. Eastman. Motion carried.

A *motion* was made by W. J. Hooker, that the amendments and changes made in the new constitution be approved. Seconded by C. Frutchey. Motion carried. Copies of the new constitution can be obtained by writing to the editor.

Financial report was presented by J. C. Campbell for the past year. A motion was made by P. J. Eastman that the report be accepted. Seconded by W. G. Hoyman. Motion carried.

Auditing Committee report was presented by W. G. Hoyman. The books of the treasurer were found to be in order and accepted.

Executive Committee report was presented by R. V. Akeley.

Handbook Committee report was presented by C. Hutchinson.

Discussion of disclaimer clause. H. M. Darling (chairman) of Seed Certification Committee suggested the following resolution; that they, (dealers) consider seriously adding a disclaimer clause to seller's invoice or bill of sale. A motion was made by J. C. Campbell that the resolution be adopted. Motion carried.

Procedure for distributing 1959 Handbook discussed. It was suggested that the Secretary write a letter to each Seed Certification Agent concerning circulation of Handbook and give them group rates and urge them to buy enough copies to give all their members. Also, Secretary

should contact the Extension Service with a similar letter to encourage distribution through their organization.

The Committee for Local Arrangements for the 1959 meeting of the Association at Fredricton, New Brunswick, submitted two alternate dates for the consideration of the Association members, subject to final sanction by the Fredricton group. Dates presented by L. C. Young were as follows:

A — Formal Meetings	August 13, 14, and 15
Optional Tours	August 12 and 16
B — Formal Meetings	August 17, 18, and 19
Optional Tours	August 16 and 20

A *motion* was made by W. Sparks that schedule A be preferred. Seconded by W. Hoyman. Motion carried.

A *motion* was made by L. Dione that the decision regarding the 1960 meeting location be delayed until next year. Seconded by W. Sparks. Motion carried.

Report of the Nominating Committee was made as follows: W. J. Hooker, President; P. J. Eastman, President-Elect; O. C. Turnquist, Vice President; Charles Cunningham, Director. J. C. Campbell moved that nominations be closed and that a unanimous ballot be cast for the slate. Seconded by W. Sparks. Motion carried.

Meeting adjourned.

Respectfully submitted,
R. V. Akeley, Secretary.

MINUTES OF EXECUTIVE COMMITTEE MEETING

Indiana University
Wednesday afternoon, August 27, 1958

Members present: R. V. Akeley, J. C. Campbell, E. J. Wheeler, W. J. Hooker, P. J. Eastman, C. E. Cunningham, D. S. MacLachlan, and N. M. Parks.

A *motion* was made by D. S. MacLachlan, that the honorary members to be selected in 1959, include technical men only; 2 from North America and 1 from Europe. Seconded by N. M. Parks. Motion carried.

John C. Campbell was reappointed for another 2 year term as Editor and Treasurer.

A *motion* was made by N. M. Parks that the editor's salary be increased $150.00 per annum. Seconded by P. J. Eastman. Motion carried.

FINANCIAL REPORT
POTATO ASSOCIATION OF AMERICA
August 1, 1957 to July 31, 1958

RECEIPTS

Cash on hand in bank, July 31, 1957	$6,573.19	
Annual dues	6,147.49	
Sale of advertising in Journal	2,118.10	
Sale of reprints	1,840.45	
Sale of back issues	321.48	
General	26.93	
Advertising in '57 Handbook	87.00	
Advertising in '58 Handbook	2,272.04	
Sale of Handbooks	343.01	
TOTAL RECEIPTS		$19,729.69

DISBURSEMENTS

Printing Journal (13 issues)	5,927.83	
Mailing and Supplies	850.20	
Printing reprints	848.90	
Salary for treasurer	720.00	
Salary for Journal editors	1,080.00	
Commission on advertising in Journal	295.35	
Purchase of back issues	205.45	
Expenses connected with annual meeting	63.41	
Purchase of office equipment	137.91	
AIBS dues	100.00	
General, advertising, extra help, etc.	159.30	
Commission on '57 Handbook ads	21.75	
Commission on '58 Handbook ads	227.20	
Salary for editing '58 Handbook	416.67	
Printing & mailing '58 Handbook	1,872.09	
Salary for editing '59 Handbook	583.33	
Savings in Family Savings & Loan Assoc.	2,000.00	
TOTAL DISBURSEMENTS		$15,509.39
CASH ON HAND IN BANK, July 31, 1958		$ 4,220.30

Family Savings & Loan Association

Cash drawn from checking account	$2,000.00	
Interest	25.00	
TOTAL		$ 2,025.00

Lelah Starks Fund

Cash in savings account, July 31, 1957	530.54	
Interest	7.98	
TOTAL		$ 538.52

REPORT OF THE LATE BLIGHT INVESTIGATING COMMITTEE

This report includes only a brief survey of the progress of work on late blight since the committee's last report. This is so because the last report, which was very complete, was prepared only about 8 months ago, and time did not permit writing a similar one which would represent the opinions of the entire committee. An excellent summary of the genetics and host-parasite relations in late blight is to be presented as a symposium paper at the meetings of the American Phytopathological Society by two members of the committee.

Workers in Canada and West Virginia report continued testing of new introductions for field resistance and major genes. Results of earlier tests at several places have been published recently. There is evidence that fifth and sixth major genes for hypersensitivity are inherited like the other four, and that genes corresponding to the latter are present in species other than *Solanum demissum*. Breeding at most stations seeks to combine as many major genes as possible with a high degree of field resistance.

The problem of testing large populations for field resistance is a rather difficult one to solve. At West Virginia ,growing plants at controlled low nutrient levels has permitted the selection of those with resistance. Studies are being made of the effects of maturity, incubation period, etc. In Canada, inoculation of seedlings in a controlled environment blight chamber has permitted the establishment of broad groups of field resistant clones. Selection in the field is complicated when major genes are present due to differences in the virulence of races. At Minnesota, races 0 and 4 have been sufficiently aggressive to permit a comparison of field resistance in clones, but other races have caused too little infection to do so. Minnesota workers are exploring the advisability of discarding material with major genes, and seeking field resistance in R_0 stock only.

Studies of the sexuality of *Phytophthora infestans* have been continued in West Virginia and Mexico, demonstrating that the fungus is bisexual and self-incompatible. Oospores like those found in culture were found in blighted leaves of Katahdin growing in Mexico, but not in the tissues of several wild species of Solanum that were examined.

In Canada and elsewhere race surveys reveal that race 4 is predominant, in contrast with the situation of a few years ago, when it seemed that race 0 was almost universally most fitted to survive on varieties without major genes. Field experiments in Minnesota indicate that individual isolates of races differ in agressiveness and ability to survive in the field. Canadian workers report isolating race 1, 2, 3, 4 a third time, this time from tomato from Nova Scotia.

The present chairman regrets that he was unable to arrange a meeting of the Committee at Bloomington that would permit adequate discussion of late blight problems and progress, particularly matters of technique and procedure of importance to future investivations. Such items suggested by members of the committee include the following:

1. Modification or expansion of the present system of race nomenclature to accommodate resistance genes which might be found in species other than *Solanum demisum*.

2. Establishment of a uniform set of differential hosts for identifying

races, and a continuing source of virus-free tubers of the same. It was suggested that committee members might exchange tester stocks and after a year or so ago agree on one set. The use of true-breeding *S. demissum* lines was also suggested, some of which have been developed by Dr. Schick of Germany.

3. A thorough discussion of the problem of testing seedlings and clones for field resistance. This should include a consideration of uniform standards for measuring field resistance, and the possibility of exchanging clones of known resistance for comparison.

John Niederhauser	L. C. Peterson
W. R. Mills	Keith Graham
R. Bonde	M. E. Gallegly
J. L. Howatt	C. J. Eide, *Chairman*

REPORT OF THE SEED POTATO CERTIFICATION COMMITTEE—1958

During the past year the committee has been concerned with two problems. The first consisted of writing brief descriptions of each of the North American potato varieties for the 1959 Association Handbook. This project was completed and the manuscript sent to the Handbook editors in March.

The second problem concerns the legal status of a disclaimer statement in connection with the sale of certified seed. The legal role of the certification agency may vary depending upon whether or not it is a direct function of a state agency or if the authority is delegated by statute to an association. By being an agency of the state it cannot be legally associated with or participate in a disclaimer. To do this the agency or state would in effect be a party to "insuring" a product or business resulting from its service activities. Legal counsel obtained by members of the committee is quite positive on this point. However, their advice indicates that a specific disclaimer could be used by the seller and the extent to which the seller can disclaim the implied warranties which arise under the "Uniform Sales Statutes" is rather well defined. In this situation purchase of certified seed is a matter of private contract and use of a disclaimer on the invoice, bill of sale, confirmation of sale or other document makes a sale subject to the conditions of the disclaimer. Any litigation would, therefore, be based on a breach of contract. If a disclaimer is used the seller is legally obligated to give adequate notice to the buyer of its existance. Such notice must be made known prior to sale and for this reason is often included on the contract or office stationery. This procedure removes many of the intangibles associated with implied warranties and the seller is in effect disclaiming any intent to warrant the seed.

The present situation indicates the problem can best be handled through use of a disclaimer by the seller. This procedure would appear to offer maximum protection to all parties. As a matter of fact, it appears that a sales agreement with a disclaimer would specifically negate prior expressed or implied warranties which arise under the uniform sales act.

For obvious reasons your committee recommends that each certification agency explore the legal aspects of this problem that may be peculiar

to their state and that all agencies adopt a reasonably uniform disclaimer statement to recommend to their growers. It is emphasized that the committee is only attempting to clarify the legal responsibilities of the seller and that the various certification agencies are not affected. The following statement has been suggested by some:

> _____ makes no warranty, express or implied, as to the quality or fitness of the seed they sell. Acceptance shall discharge the seller from liability.

Potato Certification Committee:

Karl Fernow — J. W. Scannell
T. H. Hankins — H. M. Darling, *Chairman*
R. C. Hastings

REPORT OF THE COMMITTEE ON ARRANGEMENTS FOR THE 1959 MEETING IN CANADA

The 43rd annual meeting of the Potato Association of America will be held at the Potato Research Station in Fredericton New Brunswick, Canada, on August 13, 14, and 15, 1959. These dates are just before the IX International Botanical Congress to be held in Montreal, Canada, from August 19-29, 1959.

A tentative program of invitation papers by speakers from abroad has been set up as follows: (1) Breeding and Genetics, (2) Diseases and Disease Resistance, (3) Insects and Nematodes, (4) Seed Certification and New Varieties.

A notice of the above meeting has been sent out to 140 laboratories in 35 foreign countries.

D. S. MacLachlan — L. C. Young
Ora Smith — R. H. Larson, *Chairman*

REPORT OF THE INTERNATIONAL RELATIONS COMMITTE

The Committee has not met during the past year; however, problems and prospects have been discussed by correspondence with a number of Committee members in various foreign countries. Some suggestions are as follows:

A) Compile and make available in printed form (in the American Potato Journal) as complete a list as possible of the *major* research programs under way at the present time in the various countries of the world. The compilation to include the project leaders and their affiliation. The first list to be outside of the United States and Canada. This compilation is now in press.

B) Develop a mutual understanding of the major problems in all phases of potato production confronting the different countries, and the methods used in solving them.

C) Replace the sporadic informal exchange of information and materials, between research men in different countries, by carefully planned international cooperation aimed at specific objectives.

D) A concerted effort should be made to establish an efficient and well-organized international exchange of 1) publications, 2) recently developed techniques and methods, 3) problems regarding new and important diseases, 4) exchange of seeds of indicator plants for virus studies, virus antiserum, etc., and 5) exchange of disease and insect-resistant material and tester stocks through "Plant Introduction".

R. H. Larson, *Chairman*

REPORT OF THE POTATO UTILIZATION COMMITTEE

Last December at the Beltsville, Maryland meeting Mr. Kris P. Bemis, as Chairman of the Potato Utilization Committee, submitted a report summarizing the developments in this field for the several years previous. This report, therefore, will be confined to the highlights and salient features in potato utilization during 1958.

The series of National Potato Utilization Conferences was continued with a meeting held at Eagle River and other points in Wisconsin on on August 1-4, 1958. Orrin C. Turnquist and Ernest J. Wheeler were designated to attend the Wisconsin meeting as representatives of our Association. In addition, other members of our Association attended. Informal discussions were held on the subject of how the Potato Association of America and the National Potato Conferences might be brought into a closer sphere of cooperation. Mention was made of the possibility of holding the Eleventh National Potato Utilization Conferences in the spring of 1960 in Florida in conjunction with the annual meeting of the Potato Association of America, if that arrangement would meet with the approval of our Association. While examination of the program of the Wisconsin meeting shows that this Conference was not limited to potato utilization in the strictest sense, it did provide a common meeting ground for exchange of information among those active in the field.

Research and development in potato utilization have progressed at favorable levels during the past year. A new form of dehydrated mashed potatoes, potato flakes, went into commercial production after extensive engineering studies Six plants are now ready to produce potato flakes. Dried mashed potatoes in powder form, potato granules, continue to enjoy increasing popularity particularly in restaurants and institutional use. Dehydrated diced and sliced potatoes also continue to find volume usage in canned hashes, stews, and salads.

Production and sales of potato chips are said to be advancing to higher levels with no signs of abatement. Research seeks to breed potatoes that inherently produce chips of desired color. Better understanding of the chemistry of color development during chip frying is also under study.

Although the rapid rise in the demand of frozen French fries and other frozen products seems to be temporarily halted, frozen products still comprise one of the most important processing outlets. Deceleration in the rate of increase of frozen products processing is perhaps due both to unduly rapid expansion during 1956 and 1957 and to the current business recession. A partially dehydrated, frozen mashed potato product that reconstitutes to ordinary mashed potatoes by addition of 4 parts of hot water made its appearance during 1958.

Prepeeled (sulfited) potato and canned potatoes apparently have about maintained the status quo during the year. Par-fried French fry slices, which are kept under refrigeration and finished by frying for one minute in deep fat just before serving, have become an important item for restaurants in some meteropolitan areas.

Potato salad has elicited much interest during the year. Not only is this product canned, but because of its increasing popularity in fresh form, it is also sold from the cold display cases in delicatessens and retail markets.

The ideal situation in potato processing is to use good quality raw material in food products; culls and surplus potatoes for starch and industrial uses, and leave the best quality for table use. This idea is being put into practice by one Maine firm in the tablestock, food processing, and starch businesses. Starch production continues to be recognized as having an integral part in a well-balanced potato industry New starch plants were established at Washburn, Maine, and Grafton, North Dakota during 1958. Research is progressing in the utilization of dewatered extracted pulp from the starch factories for feeding beef cattle and in methods of lowering the pollutional effect of the effluent soluables from the factories. Dried, extracted pulp is now an established feed component.

From the foregoing we see that utilization continues to be an important area in the overall potato industry. With households and the public feeding industry now consuming one pound out of every 4½ pounds of potatoes used for food in processed forms and the prospects of a continuing trend, it is important that the grower provide the processor with what he needs. The future of the potato industry is definitely concerned with the development of new and improved processed foods as well as providing the consumer with a high quality fresh product.

D. R. Isleib E. J. Wheeler
R. L. Sawyer P. A. Xander
O. C. Turnquist R. H. Treadway, *Chairman*

REPORT OF LIAISON OFFICER OF EUROPEAN ASSOCIATION FOR POTATO RESEARCH AND THE POTATO ASSOCIATION OF AMERICA

The Fourth International Informal Potato Conference was held at Lund, Sweden, August 12-14, 1957. The conference was attendend by 114 persons from 114 European countries. At a special session of this conference the European Association of Potato Research was formed and the constitutions ratified. Dr. B. Emillson of Sweden was elected as first President. The broad aims of this new organization are "to promote the exchange of scientific and general information relating to the potato industry between the various countries of Europe and to encourage and assist international cooperation in the study of problems of common interest in this field". These aims are to be achieved: (1) through the setting up of subject sections for the study of specialized problems, (2) the holding of an international conference in a different country every three years and (3) by publishing the European Potato Journal.

Subject Sections

The Committee of the European Association for Potato Research (EAPR) met at Wageningen, January 30-31, 1958. Dr B. Emillson was appointed liaison officer to the Association of Scandinavian Agronomists, Dr. B. Jacobsen as liaison officer to the European Association for Research on Plant Breeding and Dr. Ora Smith as liaison officer to the Potato Association of America.

A meeting was held at Wageningen in February 1958 of a number of research workers from various European countries engaged on problems relating to "potato quality". As a result of this meeting it was decided to set up a study group within the EAPR. Dr. J. Münster of Switzerland was elected chairman of this studygroup and Mr. C. Lugt of Wageningen, secretary.

A study group for the "mechanization of potato growing" has recently been set up in Denmark. Dr. Simons of Germany was appointed chairman and Mr. E W. Boogaard of Wageningen, secretary.

The EAPR and the chairman and secretary of the European Association for Research on Plant Breeding met on January 3, 1958. A discussion was held on the definition of the spheres of interest and future cooperation of the study groups of the two associations. It was unanimously agreed that questions of interest to both societies should be dealt with in close cooperation.

International Conferences

The next potato conference, the first one of the European Association for Potato Research, is to be held at Volkenrode, near Brunswick, West Germany, in 1960.

European Potato Journal

The first two numbers of volume 1 have appeared, dated March and June 1958 containing 83 and 75 pages respectively. Four numbers are planned annually. This is an excellent publication of unusually high quality. Papers are of a high caliber and represent a good cross section of research in various phases of the potato and from a number of European countries. An excellent job of editing has been done. Papers are published in English, German or French with resumes in the other two languages. Most papers thus far have appeared in English. It is printed on high grade paper and contains clear, concise photographs and graphs.

It is hoped that many of you will join this Association and subscribe to the Journal. At our present rate of money exchange the annual membership dues and subscription to the Journal combined are $5.27 Early in May I sent about 100 copies of Volume 1 No. 1 to members of the Potato Association of America, libraries, etc., urging them to subscribe to this Journal. I'm sure if you do, you will be pleased with it. We should at least have it available in our libraries.

Officers of the association are as follows:

President —Prof. Dr. O. Fischnich
Vice-Pres.—Dr. A. R. Wilson
Secretary —Dr. D E. Van der Zaag
Treasurer
and Editor—Dr. W. H. de Jong

Council —Dr. B. Emillson Dir. P. Madec
B. Jacobsen Dr R. Salzmann

This is our first sister organization, planned similarly to the Potato Association of America, and therefore, worthy of our support, interest and cooperation. It will make it possible for us to become better informed of the research and other activities conducted in the European countries and I'm sure all of you, like myself, cordially welcome this new organization and its members into the organized potato field. On behalf of the Potato Association of America I extend to them our heartiest greeting and wishes for a long and highly successful future.

Ora Smith

SOME IMPORTANT ASPECTS OF COOKING QUALITY CONTROL IN POTATOES

Report of Nutrition Committee, Potato Association of America

Superior cooking quality in potatoes, under our present system of marketing today, is a one-sided benefit to the consumer and of little profit to the producer. Unless a potato grower markets his crop under his own brand name or sells it to potato processors, any direct benefit due him from high cooking quality of his crop is practically lost. With one notable exception, "table stock" is marketed under general classifications such as "round whites, Katahdin-type, *etc.* and rarely is there even a variety designation. No milk dealer would think of buying milk without a butterfat test, but potatoes for the most part are marketed without regard to one of their most important characteristics—cooking quality.

Yield and Grade Paramount

By and large, the marketing system being what it is, there is little incentive to place cooking quality above yield and grade. Moreover, since public opinion varies considerably as to just what is wanted in cooking quality it would, at present, be very difficult for a grower to decide, without careful study of the market, what cooking quality to aim for. From the consumer's standpoint, housewives will tell you that they prefer Long Island potatoes or Maine potatoes or Idaho bakers, but the variety and grower's name are unknown to them. Consequently if they happen to buy potatoes that cook and taste to suit them there is no way at present for them to exercise their preference another time, except by regional choice. Potato growers themselves often have a variety preference based on cooking quality which accounts for the existence of what might be called a "Potato grower's potato". For example, a grower may raise Katahdins, Sebagos, or Chippewas for market but for his own table he grows a patch of another variety, more to his liking.

Processed Potatoes an Exception

In the case of potatoes for processing, the manufacturers do have an opportunity to exercise preference, but even such preference is sometimes limited by seasonal fluctuations in yield caused by disease, weather, and other factors affecting supply. Furthermore, since potato processors usually buy in large quantities at the production source they can, by careful inspec-

tion of the crop, preliminary specific gravity tests, cooking tests, *etc.*, make fairly certain they are getting the quality they need for their product. Sections of potato-growing regions that produce suitable processing potatoes for particular purposes are well known to large manufacturers.

Quality Improvement Largely a Matter of Education

It can be stated with assurance that any research program aimed at improvement and reasonable control of cooking quality in potatoes will fall far short of expectations unless it is coordinated with an educational program for growers. Growers can be expected to respond to a quality improvement program if they are given a price incentive, especially if the program also provides for identification and transport of the higher quality product directly to the consumer. Much of the practical information required to initiate such a program is already known or is in print. At present it seems to be largely a problem that can be properly handled by extension workers and marketing specialists. They should be able to make the necessary decisions regarding the kinds of quality preferred by the consumer and the best means of getting it to him.

What is Quality?

Although we ordinarily refer to quality in potatoes as a specific characteristic, it is well established that desirable culinary quality can mean several things to several people. That is one reason why it is so important to arrive at definite decisions regarding what quality or qualities need improvement before research can be initiated to find ways of improving them. In all fairness to potato growers and shippers and also retailers, it should be stated that the general appearance, and to a large degree, the cooking quality of potatoes being sold on many retail markets have markedly improved during the last two years. This is also to the credit of the potato breeder who has been severely criticised recently in some quarters for selecting for shape, shallow eyes, and disease resistance at the expense of quality and flavor.

Cooking Quality and Flavor a Paradox

Until definite decisions are made regarding which specific qualities are to be improved the task of deciding the best means to make them cannot be undertaken in a realistic manner enabling reproduction with reasonable assurance. As one attempts to dissect the components of culinary quality and palatibility in potatoes, the problem of control appears to be more and more a paradox. Each factor seems to constitute a variable element in a greater complex of elements The more one strives to understand the factors that interact to make good quality the more he is impressed by the seeming futility of attempting to control and predict quality. A rational approach to the study leads inevitably to the conclusion that quality is an equilibrium of a combination of factors and not one factor alone. Yet one factor, if abnormal, can have a controlling influence on the resulting quality.

Specific Troubles

In some potato sections, however, specific troubles crop up from time to time to cause poor quality. One of these is the occurrence of hard spots

in the flesh of the tuber, usually in the medullary, that refuse to cook soft. Others are the occurrence of internal browning and blackening after cooking. The work that has been done so far on these problems tends to lead to the conclusion that weather conditions and variety are the influencing variables, either directly or indirectly.

In order to get an overall picture of the general problem of culinary quality, the factors believed to be important have been listed catagorically and highlights of the work done on each have been included.

Variety: Whenever cooking quality is under consideration the foremost factor in importance is the variety. Although there is a great difference in the cooking quality of varieties, yet according to Stevenson there are sometimes greater differences between samples of the same variety grown under different conditions. For example, Irish Cobbler grown to maturity in Maine has quite a different cooking quality from the same variety grown as an early crop in North Carolina. Stevenson further states that no variety has ever been produced that will have the same quality under all environmental conditions. Varieties unquestionably possess in their genetic constitution hereditary factors which render them good or bad in cooking quality, but their expression is markedly affected by environment. Nevertheless over the years varieties have become known for baking, boiling, chipping, or French frying, but this does not necessarily mean that such designations are by any means infallible.

Seasons: Perhaps the greatest environmental influence on the quality of potatoes is the kind of season. This point is recognized to such an extent by potato growers that they sometimes refer to a particular season as one of high or poor quality. Hardenburg states that the effects of weather on the quality of potatoes are extremely complex involving not only total rainfall and mean growing season temperature, but also rainfall distribution, fluctuations and extremes of temperature, length of growing season, wind velocity, relative humidity, total sunshine, and quality and intensity of light. Furthermore, there is a critical period about six weeks after planting when these factors have the greatest effect on quality and yield. For these reasons quality studies that are conducted on potato varieties without prior knowledge of the growth conditions can be very misleading.

Season, soil type and temperature frequently vary with location which accounts for the statement frequently repeated by many workers that location had the greatest influence on potato quality. Bushnell found that high temperatures at night increase respiration and thus affect the yield and quality of potatoes. This accounts in part for the more favorable environment that exists for potato growing in the northern states where the longer days favor photosynthesis and the cool nights keep respiration at a minimum. Even though potatoes are planted in southern regions in order to avoid the highest temperature, the quality in the winter is rarely equal that of the northern-grown crop.

Soil: The type of soil used for growing potatoes can have a marked influence on potato quality. This effect may be direct or indirect. The direct effect is usually caused by the physical condition of the soil. Occasionally a soil, for no apparent reason, will impart an "earthy" flavor to potatoes which is very objectionable. The indirect effects of soil are related to its water-holding capacity and temperature which in turn, affect the mineral nutrition of the crop. Williman and West found that loam soil induced

the highest dry matter, nitrogen and ether extracts whereas sand gave the lowest dry matter, and clay the lowest nitrogen. Dunn and Rost obtained the highest cooking quality on the lighter types of soil with sufficient clay and fine particles. The soil type, Berk's shale loam, produces the finest quality chipping potatoes grown in Pennsylvania.

Nutrition: The kind and amount of fertilizer used on potatoes can affect the composition of the potatoes to some degree, but as a rule fertilizing practices have become so well established in commercial areas that a so-called "potato fertilizer" can usually be relied on to give good results. All commercial growers in the east know they have to use a complete fertilizer for best results. This is usually a 1-2-1, 1-2-2, 2-3-3, or a 1-1-1 ratio selected according to soil and crop needs. The amount used per acre varies according to a number of factors such as fertility level of the land, yield goal, credit status, *etc.* Usually the recommendations of the local county agent are a safe guide where personal experience is lacking.

It is true that different workers have shown the effects of either high nitrogen or high potash on the starch, dry matter, and mineral constituents of potatoes but as a rule such unusual mixtures are not available to growers. Only a very few potato growers mix their own fertilizer, so they depend upon the manufacturers who, as a rule, sell the analyses that are recommended or they soon lose business. It should be remembered that the potato crop has been fertilized ever since complete fertilizers were first made so that trade knowledge is quick to comply with current demands based on actual experience and crop response. Furthermore, with production costs what they are today it is reasonable to assume that any tendency to over-fertilize to the extent of possibly affecting quality will be sharply checked by economic considerations.

Vine Killing: Killing potato vines prior to harvest is a relatively recent practice among potato growers. The effects of this practice on potato quality is usually associated with a discoloration adjacent to the vascular tissue of the tuber. Hoyman found that this discoloration was less when the vines were killed late in the season and it was also correlated with the rapidity of kill. Kunkel found that vine killing also tended to produce tubers with lower specific gravity, probably due to the shortening of the growing season. There is a possibility that the need for vine killing could be avoided by curtailing the amount of fertilizer used in some instances but just how far a grower could go in this direction would depend almost entirely upon local conditions on each farm. Another approach would be to use an early-maturing variety that would die off naturally in about 100 days or less.

Storage: Temperature, length of storage, and humidity all are known to affect the cooking quality of potatoes. Sometimes cultural factors interact with storage conditions to affect quality. For example, it is commonly thought by growers on the South Shore of Long Island that a fertilizer with 10 per cent potash will produce potatoes with better keeping quality than those grown with only 5 per cent potash. If true, this could be explained by the higher moisture content and lower respiration of potatoes grown with high-potash fertilizer. Wright found storage conditions to have a marked influence on the chipping quality of potatoes but the response of different varieties and the same variety grown at different locations varied considerably with the same storage and reconditioning treatments.

Sebago variety, which is only fair in general cooking quality, proved to be one of the best "chippers". Wright also found that potatoes stored at a temperature varying from 50°-60° F. have better texture, color, and flavor when cooked than the same stock stored at lower temperatures. It is well known that some varieties are more susceptible to storage defects than others. Green Mountain, for example, develops very poor cooking quality and blackens badly after a long storage period.

What Quantitative Measure of Quality?

As a result of an exhaustive study on cooking quality and composition of certain potato varieties, Hienze *et al* came to the conclusion that specific gravity determination is the best practical measure of cooking quality. It compares favorably with dry matter, alcohol-insoluble solids, and starch as a measure of cooking quality but has, however, the distinct advantage of being easiest to obtain. The advantages of the specific gravity method have been recognized for more than 100 years and today a number of investigators advocate its use.

Conclusions and Recommendations

Since a large amount of information is already available on the factors affecting cooking quality of potatoes and since the expression of these factors is so dependent on seasonal and local conditions, it would seem at this time that an educational program could be helpful in raising the general cooking quality level of potatoes.

Any research work that might be undertaken concerning specific quality effects would necessarily encounter at the outset such problems as: means of providing fertilizers of definite composition, land suitable for potatoes that is under the full control of the investigator, machinery and suitable labor for planting, care, and harvesting the crop, laboratory facilities and chemically-trained assistance, and possibly greenhouse space.

Since cooking quality is a general term it would be highly desirable, if not essential, to select one or two factors for study that are considered to have definite influence on quality in any particular section and concentrate research effort on them. This may resolve itself into merely a test of suitable varieties or it could lead to a comprehensive biochemical study of one variety. Regardless of the approach it is certain that any improvements in the cooking quality of potatoes whether effected through education or research can be made to benefit both the grower and the consumer. To this end this discussion has been published in order to present a more comprehensive picture of the problem in the hope that interest in the subject of potato cooking quality will be increased thereby. The statements made have been approved by the Nutrition Committee and represent their own viewpoints.

G. V. C. Houghland, *Chairman*
Arthur Hawkins
O. A. Lorenz
N. R. Richards
L. M. Ware

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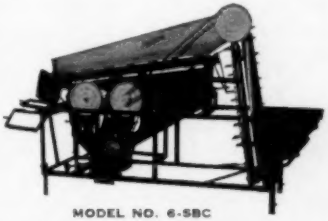

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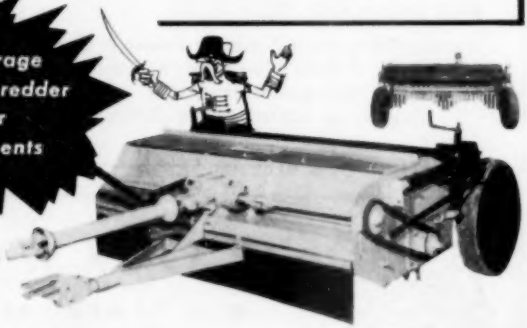

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